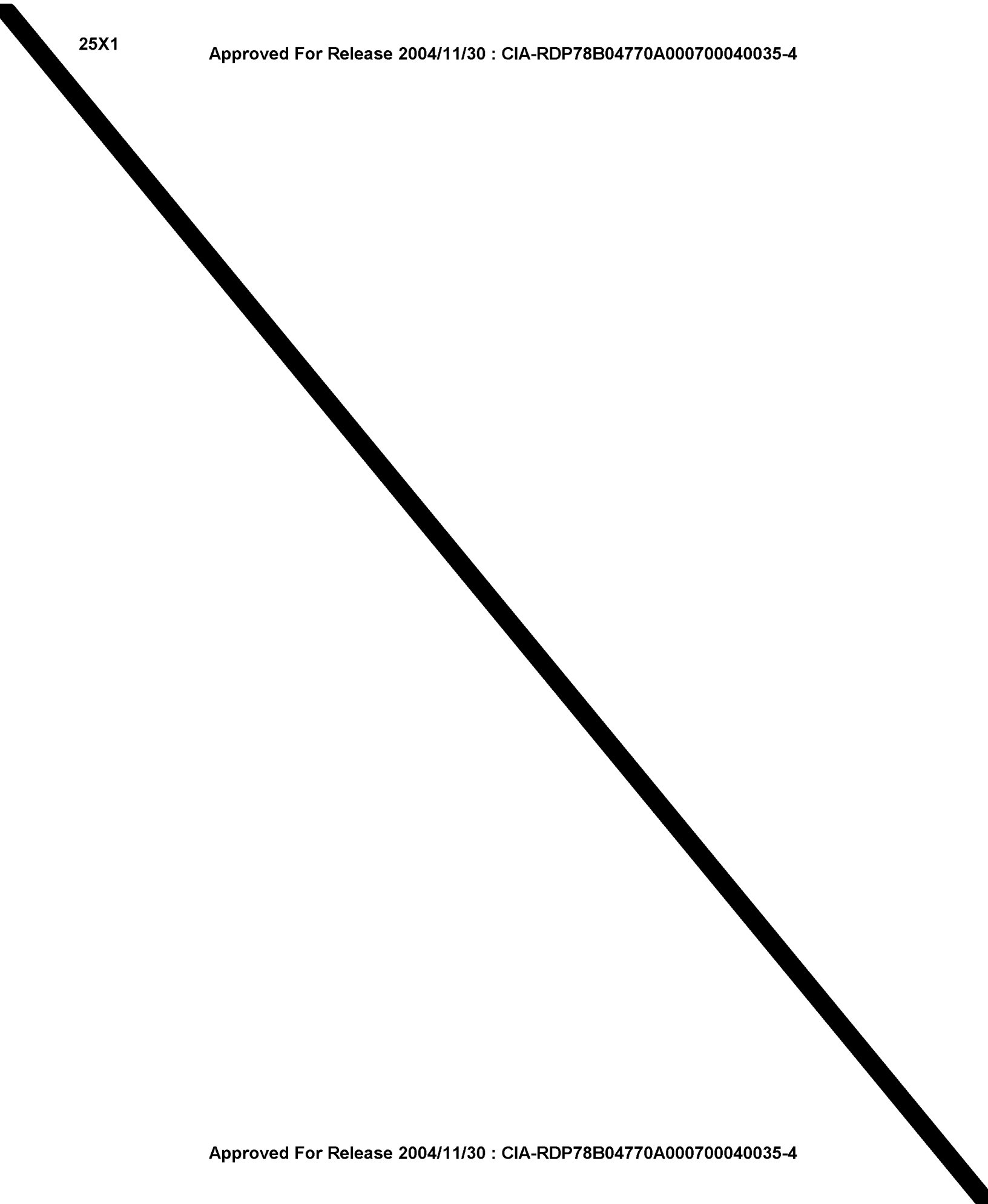

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12 April 1965

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MEMORANDUM FOR: Deputy Director (Science and Technology)

SUBJECT: Some Views on the Effects of Stereo-Convergence and Obliquity Angles on Photographic Analysis at NPIC

REFERENCES:

a. [redacted] 25X1
"Height Measurement Accuracy as a Function of Stereo-Convergence and Obliquity Angles", Feb. 1965

b. [redacted] 25X1
[redacted] Report: "The Effects of Stereo-Convergence and Obliquity Angles on the Judged Worth of Aerial Photographs", March 1965

c. [redacted] 25X1
[redacted] Report: "Aircraft Image Analysis as a Function of Photographic Ground Resolution", December 1964

d. [redacted] 25X1
[redacted] Report: "A Study of Photo-Image Recognition as a Function of Ground Resolution", February 1964

1. The NPIC has undertaken several preliminary investigations into the subject question. These studies were undertaken on an accelerated schedule in view of time limitations related to new system development deadlines and were managed around the full-time commitment of our people to actual operations and the consequent premium placed upon P. I. time.

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[redacted]

We must therefore treat the results of the referenced studies accordingly, i.e., as preliminary indications. This is not to depreciate their value, for at the same time, we must also consider them the most significant data we yet have to rely upon and the most pertinent investigative work available to date.

The results of these, coupled with experience factors derived from extensive work with a diversity of photography, leads the Center to note the following views in the hope that they will be useful to the DD/S&T.

a. Stereo-Convergence Angles

Briefly, a pair-comparison test was run using a sample of 16 experienced photo interpreters to evaluate convergence angles of 10° , 20° , and 30° from materials simulating the quality of a proposed system. (Convergence angles exceeding 30° were not tested since the upper limit of useable stereo is set by the eye's ability to physically merge stereo images.)

Results showed that variations between 10° and 30° of stereo convergence angle have little or no significant differences for photo interpreters. Intuitive predictions of responses would of course lead one to assume that variations in the angle would be a relatively significant factor in the stereo-viewing and interpretation process. The study referenced as b. not only refutes this but also shows with good replication that, to a P. I., the difference in worth particularly between angles of 10° and 30° would be negligible.

This conclusion, however, must now be registered with the results of a parallel study -- a strictly mathematical analysis (reference a.) of height by parallax measurement accuracy as a function of the same range of convergence and obliquity angles that were evaluated by P. I.'s. It is in the photogrammetric analyses, which are an inextricable part of NPIC's product, that stereo-convergence angles do have a significant effect.

An examination of the graphs in reference a. reveals that critical degradation in parallax-height measurements occure with stereo-convergence angles of less than 20°. (Additional work is currently underway to examine effects on plane measurements of a variety of types.)

Thus, it is the Center's recommendation that total (included) stereo-convergence angles less than 30° could sensibly be considered but that total angles less than 20° must be avoided.

b. Obliquity or Scan Angles

For the general range of obliquities from 0° to 60°, it is obvious that as obliquity increases both resolution and P. I. performance fall-off proportionately - a net effect of progressive degradations from scale, haze, target orientation and of difficulty for the visual system in stereo-fusion.

For a specific system and its proposed resolution range reference b. shows that P. I. s assigned no significant difference to the relative usefulness for detailed intelligence requirements of 0°, 10° and 20° of obliquity; and it verifies that, as could be expected in view of progressive degradations, there was a significant drop in the judged worth of 20° to 60° obliquity coverage. The significance of the fall-off, however, depends on some outside factors: That is to say, definitive recommendations for a maximum scan angle are difficult because 1) even high or far obliquities are always desirable as a "bonus" effect; and 2) because information on the orbital parameters of future operational missions has been limited to date. For instance: if mission-life or orbital characteristics of any one system precluded coverage of areas of specific interest with smaller scan angles, large scan angles would certainly have to be acceptable and relative worth scaled according to resolutions attainable.

Furthermore, from reference c. and an earlier pilot study (reference d.) was derived the general indication that P. I. response accuracy increases sharply (approximately 30%) with ground resolutions increasing in quality from 10 feet

2. In summation, the Center suggests that factors such as priority target descriptions, their ground resolution requirements as stated by the COMOR, which take into account their specific essential elements of information (EEIs), be used with mission-life and planned orbital characteristics to define the angle of obliquity at which specific targets should be covered. The general statement by the Center that the smaller obliquity angles permit more accurate and complete photo interpretation continues to be valid.

ARTHUR C. LUNDAHL
Director
National Photographic Interpretation Center

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